PRELIMINARY NOTE ON SOME EXPERIMENTS WITH A POLYMORPHIC PHASMID.

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Among a large brood of "stick-insects," reared from the egg by Mr E. E. Green, Government Entomologist in Ceylon, it was noticed that, though the ♂s were all similar, two distinct types of ♀ were present. The case seemed to merit a detailed investigation, the preliminary results of which are presented in the following notes.

The insect in question is a typical apterous "stick-insect," the general appearance of which can be seen at once from the plate (Plate III); the special characters studied in the experiments were firstly the colour of the adults, and secondly the presence or absence of pointed conical horns on the head (Figs. 4, 5). With respect to these characters the ♂ never varies; it never has horns, is always dark chocolate brown in colour and is a much more slender insect than the female. In the original brood two forms of ♀ were observed, the one being horned and green in colour, while the other was hornless and yellow.

This dimorphism in the ♀ in relation to the presence and absence of horns leads to a difficulty in determining the specific identity of the insect. It belongs to the division *Clitumnini* of Brunner v. Wattenwyl and Redtenbacher, but falls into the genus *Clitumnus* Stal. or *Cuniculina* B. v. Watt. according to whether the ♀ is without horns or possesses these appendages. Both Westwood in his Catalogue of the Phasmidae[1] and Brunner v. Wattenwyl and Redtenbacher in their celebrated

[1] *Catalogue of Orthopterous Insects, Phasmidae*, p. 9, Pl. 5, Fig. 2.

monograph[1] of the group express a distrust of the character, and it is now evident that the genus *Cuniculina* as described by the second author must be dropped. The hornless ♀ has not been satisfactorily determined, but the horned ♀ appears identical with Bacillus cuniculus Westw., and it will be sufficient for this paper if the subject of the experiments is assigned to *Clitumnus* sp?, probably *Clitumnus cuniculus* Westw.

The first two experiments consisted in isolating a horned green ♀ and a hornless yellow ♀ from the original brood and, as the ♂s and ♀s had been left together after reaching maturity, it is assumed that both these ♀s had paired.

The following table shows the distribution of the two pairs of characters among the descendants of these two ♀s and their progeny.

Brood Number	Parentage	Males	Horned green female	Hornless green female	Horned yellow female	Hornless yellow female
1	Horned green ♀ × ♂ unknown	13	3	3	10	8
2	Hornless yellow ♀ × ♂ unknown	3	—	—	—	2
3	Hornless green ♀ 1 × ♂ 1	48	—	38	—	42
5	Horned green ♀ 1 × ♂ 1	30	3	8	8	11
6	Horned green ♀ Parthenogenetic	—	12	10	—	—
7	Hornless yellow ♀ 1 × ♂ 1	Died young.		Some ♀s with horns		
8	Hornless yellow ♀ 1 × ♂ 1	10	—	—	1	7
9	Horned yellow ♀ 1 × ♂ 1	46	4	6	18	23
10	Horned yellow ♀ 1 × ♂ 1	24	4	2	17	1
11	Hornless yellow ♀ 2 × ♂ 2	47	—	12	—	43

Note. The number following an individual shows the brood from which it was taken. Brood 4 died young and is omitted. In Brood 10 the two hornless green ♀s died when immature and there is some doubt as to their colour.

These results are puzzling in many ways, yet certain facts stand out clearly. It is evident that the characters of the presence and absence of horns are Mendelian, as also are those of colouration, and with respect to both it is noteworthy that no intermediates occurred, so that every individual could be assigned definitely to one of the four classes. The connection between the possession of horns and the green colour, suggested by the original brood, evidently does not exist, and the two pairs of characters are probably quite independent of each other. Finally, and most important, is the definite evidence in brood No. 6 of the segregation of Mendelian factors in parthenogenetic reproduction. There appear to be no previous records of this phenomenon and consequently confirmation is desirable; at the same time the absence of

[1] *Die Insektenfamilie der Phasmiden*, p. 196.

♂s and the fact that the segregating character is structural seem to be strongly in favour of the correctness of the result.

As a working hypothesis for the explanation of the experiments as a whole it may be supposed that horns are caused by the presence of a factor *H*, in the absence of which, represented by *h*, the insect is hornless. Similarly as yellow colouration appears to be dominant over green it may be due to a factor *C*, in the absence of which, *c*, the insect is green. Then if the sex factors are represented by *MM* in the ♂ and *MF* in the ♀ it must be supposed that the combination *MM* inhibits the appearance of the female secondary sexual characters.

Under this scheme the ♂s and ♀s must have the following constitutional formulae.

Males	Horned yellow females	Horned green females	Hornless yellow females	Hornless green females
MMHHCC	*MFHHCC*	—	—	—
MMHHCC	*MFHhCC*	—	—	—
MMHHCc	*MFHHCc*	—	—	—
MMHhCc	*MFHhCc*	—	—	—
MMHHcc	—	*MFHHcc*	—	—
MMHhcc	—	*MFHhcc*	—	—
MMhhCC	—	—	*MFhhCC*	—
MMhhCc	—	—	*MFhhCc*	—
MMhhcc	—	—	—	*MFhhcc*

Brood 1 arose from a horned green ♀ and contained (*a*) about equal numbers of horned and hornless ♀s, (*b*) green ♀s and yellow ♀s in the ratio of 1 : 3.

As regards horns the parent ♀ was evidently heterozygous for *H* and the parent ♂ contained *hh*, lacking *H* altogether.

The colour problem is more difficult and can only be explained by supposing that the ♀ paired more than once, which was possible, since it was left for some time in a cage with numerous ♂s. The formula of this ♀ is *MFHhcc* and if it paired first with a ♂ of constitution *MMhhCc* and then with one *MMhhCC* an excess of yellow offspring would be produced.

Brood 3. A hornless green ♀ from brood 1 paired with a ♂ of the same brood and gave approximately equal numbers of hornless yellow and green ♀s. The parent ♀ being *MFhhcc*, the parent ♂ must have been *MMhhCc* and the result is an equal number of yellow ♀s *MFhhCc* and green ♀s *MFhhcc*.

Brood 5. A horned green ♀ from brood 1, paired with a ♂ of brood 1, gave 11 horned ♀s to 19 hornless ♀s, and 11 green ♀s to

19 yellow ♀s, numbers which are difficult to reconcile with the hypothesis. The most probable cross is *MFHhcc* × *MMhhCc* which ought to have given equal numbers of each class.

Brood 6. A horned green ♀ of brood 1 parthenogenetically gave approximately equal numbers of horned and hornless green ♀s. The parent was evidently heterozygous for *H* and the offspring would presumably be *MFHhcc* and *MFhhcc*.

Broods 7 *and* 8 are only of interest as showing that horns can be introduced by the male parent.

Brood 9. A horned yellow ♀ of brood 1 by a ♂ of the same brood gave 22 horned ♀s and 29 hornless, while as regards colour there were 10 green ♀s to 41 yellow.

The cross which would give the nearest result to this would be a ♀ *MFHhCc* by a ♂ *MMhhCc* giving equal numbers of horned and hornless ♀s and green ♀s to yellow ♀s in the ratio 1 : 3.

Brood 10. A horned yellow ♀ of brood 1 by a ♂ of brood 1 gave 21 horned ♀s to 3 hornless, and 18 yellow ♀s to 6 green. This is another doubtful brood, but the most probable cross to have produced it is *MFHhCc* × *MMHhCc*, giving 3 horned to 1 hornless and 3 yellow, 1 green.

Broods 2 *and* 11. In brood 2 a hornless yellow ♀ gave an F_1 containing only hornless yellow ♀s but in brood 11, the F_2 generation, both hornless yellow and hornless green ♀s appeared—12 green, 43 yellow. The first cross may have been either *MFhhCc* × *MMhhCC*, or *MFhhCC* × *MMhhCc*, and in either case the F_1 contained individuals of constitution *MFhhCc* and *MMhhCc*, which if paired would give 3 yellow ♀s, 1 green ♀.

As a whole it is evident that the numbers realised in the experiments do not agree well with those demanded by the hypothesis, but in this connection it is necessary to point out that there was a very high mortality during the early stages of the insect's life, which might easily have disturbed the relative numbers, in which the various forms of ♀ occurred. It is hoped however that further experiments will be made with the species and the results, especially those to be obtained from broods produced parthenogenetically, should be of great interest.

Finally an expression of gratitude must be made to Mr E. E. Green, who provided the material for experiment and thanks are also due to Professor Punnett and Mr L. Doncaster for much advice.